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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/653,561	08/31/2000	Larry Hillyer	M4065.0239/P239	5354

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Washington, DC 20037

EXAMINER
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NGUYEN, HA T

ART UNIT	PAPER NUMBER
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2812

DATE MAILED: 11/24/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

## Office Action Summary

**Application No.**

09/653,561

**Applicant(s)**

HILLYER ET AL.

**Examiner**

Ha T. Nguyen

**Art Unit**

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

### Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

### Status

- 1) ☒ Responsive to communication(s) filed on 29 September 2004.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

### Disposition of Claims

- 4) ☒ Claim(s) 1-4, 6-18, 20-31, 34-39, 41-44, 50, 52-95 and 97 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-4, 6-18, 20-31, 34-39, 41-44, 50, 52-95 and 97 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

### Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

### Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some \* c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
  2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
  3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- \* See the attached detailed Office action for a list of the certified copies not received.

### Attachment(s)

- |  |   |
|--|---|
| 1) <input type="checkbox"/> Notice of References Cited (PTO-892)   | 4) <input type="checkbox"/> Interview Summary (PTO-413)<br>Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948)                                   | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152)             |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)<br>Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____  |

## **DETAILED ACTION**

### ***Notice to applicant***

1. Applicants' Amendment and Response to the Office Action mailed 6-29-4 has been entered and made of record .

### ***Claim Objections***

2. Claims 30 and 31 are objected to because of the following informalities: in claims 30 and 31, lines 2, substitution of "and" with --then contacting-- is suggested for correctness. Appropriate correction is required.

### ***Claim Rejections - 35 USC § 103***

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103<sup>®</sup> and potential 35 U.S.C. 102(f) or (g) prior art under 35 U.S.C. 103(a).

4. Claims 16, 29, and 54 are rejected under 35 U.S.C. 103(a) as being unpatentable over in view of Zhao et al. (USPN 6204192, hereinafter "Zhao"), in view of Chen (USPN 5970376).

Referring to Figs. 1-8 and related text, Zhao discloses a method for removing polymer etch residue from an etched opening in a silicon wafer device, comprising the steps of: contacting said opening with a first plasma to remove a portion of said etch residue, stopping

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said first plasma contacting before said polymer etch residue is completely removed and thereafter removing any remaining said residue by contacting said opening with a second plasma, said second plasma consisting of a hydrogen containing gas (See col. 4, line 37- col. 5, line 39). Zhao also discloses removing photoresist by oxygen ashing (see col. 1, lines 54-63). It is inherent that some residue is also removing in the ashing step. But it fails to disclose expressly first plasma consisting of oxygen. However, the missing limitation is well known in the art because Chen discloses this feature (See cols. 10 and 11).

A person of ordinary skill is motivated to modify Zhao with Chen to remove photoresist by a conventional process .

Therefore, it would have been obvious to combine Zhao with Chen to obtain the invention as specified in claims 16, 29, and 54.

Note: Because of the large number of claims the following rejection will mainly address the claimed features without, at every rejection, specifically indicate the identification number of all the claims containing the rejected features.

5. Claims 1-4, 6-18, 20-31, 34-39, 41-44, and 54-91 are rejected under 35 U.S.C. 103(a) as being unpatentable over Zhao in view of Smith (USPN 6277733)

[Re claims 1, 16, 29, 54, and 70] Zhao discloses substantially the limitations of claims 1, 16, 29, 54, and 70, as shown above. But it fails to disclose expressly the use of  $\text{NH}_3$  or  $\text{CH}_4$ .

However, the missing limitations are well known in the art because Smith discloses ammonia,  $\text{H}_2$ , or  $\text{CH}_4$  are equivalent gases for removing organic containing material (see col. 4, lines 8-26);

[Re claims 2 and claims reciting similar feature(s)] Smith also discloses wherein said opening is a HAR contact opening (see Fig. 2f);

[Re claims 3 and claims reciting similar feature(s)] wherein said contacting is performed under conditions effective to remove said etch residue without substantially increasing the size of said opening (See col. 1, 54-56); and

[Re claims 4 and claims reciting similar feature(s)] wherein said opening is contacted with ammonia,  $\text{H}_2$ , or  $\text{CH}_4$  gas in the absence of oxygen (See col. 4, lines 8-48).

[Re claims 6 and claims reciting similar feature(s)] Zhao also discloses wherein said contacting with said second plasma is done at a temperature within the range of about 250-500° C (see col. 5, lines 5-22);

[Re claims 12-13 and claims reciting similar feature(s)] wherein said contacting with said second plasma is performed for a period of less than about 100 seconds; for a period of not more than about 75 seconds (see col. 5, lines 23-39).

[Re claims 14 and claims reciting similar feature(s) ] forming a conductive layer at the bottom of said opening following said contacting step (see col. 5, lines 40-51);

[Re claims 15 and claims reciting similar feature(s) ] wherein said opening forming step produces silicon nitride at a bottom of said opening, said method further comprising said silicon nitride (see col. 4, lines 17-36);

[Re claims 26 and claims reciting similar feature(s) ] wherein said bottom of said opening is not oxidized during said second plasma contacting step (see par. bridging cols. 4 and 5).

[Re claims 7-9, 11 and claims reciting similar feature(s)] Zhao discloses substantially the limitations of claims 7-9, 11 and claims reciting similar feature(s), as shown above. But it fails to disclose expressly the details about said opening and the conditions for applying the first or second plasma. However any variation in parameters in the present claims is obvious in light of the cited art, because the changes in parameters produce no unexpected function.

The routine varying of parameters to produce expected changes are within the ability of one of ordinary skill in the art. Patentability over the prior art will only occur if the parameter variation produces an unexpected result. In re Aller, Lacey and Hall, 105 U.S.P.Q. 233, 235. In re Reese 129 U.S.P.Q. 402, 406.

[Re claims 41-44] Zhao also discloses wherein an insulating layer is formed on said device prior to said etching and said etching forms a contact hole in said insulating layer by dry etching; said dry etching is performed using at least one gas selected from the group consisting of  $\text{CH}_2\text{F}_2$ ,  $\text{CHF}_3$ ,  $\text{CH}_2\text{F}_6$ ,  $\text{C}_2\text{HF}_5$ ,  $\text{CH}_3\text{F}$  (See col. 4, lines 17-36).

Therefore, it would have been obvious to combine with to obtain the invention as specified in claims 1-4, 6-18, 20-31, 34-39, 41-44, and 54-91.

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6. Claims 50, 52-53, 92-95, and 97 are rejected under 35 U.S.C. 103(a) as being unpatentable over Zhao in view of Smith, as applied above, and further in view Kawai (USPN 6284664) and Hamada (USPN 6291890).

The combined teaching of Zhao and Smith discloses substantially the limitations of claims 50, 52-53, 92-95, and 97, as shown above.

But it fails to disclose expressly forming an insulating layer over a polysilicon region; forming a Ti silicide layer at the bottom of said opening in contact with said polysilicon layer.

However, the missing limitations are well known in the art because Kawai discloses forming an insulating layer 18 over a polysilicon region 14; forming a contact opening in said insulating layer down to said polysilicon region using a fluorine containing gas (see col. 4, lines 4-18); removing polymer residue from said contact opening using a gas (see col. 4, lines 26-58) and Hamada discloses forming a titanium silicide 111 at the bottom of an opening in contact with said polysilicon layer 104; forming a conductor 112 in said opening in electrical contact with said silicide (see Fig. 3D and col. 5, lines 1-20).

A person of ordinary skill is motivated to modify Zhao and Smith with Kawai and Hamada to obtain improved connection conductivity to a gate region.

Therefore, it would have been obvious to combine Zhao and Smith with Kawai and Hamada to obtain the invention as specified in claims 50, 52-53, 92-95, and 97.

### ***Response to Amendment***

7. In view of Applicants' arguments and the amendment to the claims, the rejections of claims 30-31 and 34-38 under 35 U.S.C. 112 second paragraph, as being indefinite, has been withdrawn.

Applicants' arguments with regard to the rejections under 35 U.S.C. 103 have been fully considered, but they are not deemed to be persuasive for at least the following reasons.

Applicants argued that Zhao in view of Chen does not teach "contacting said opening with a plasma consisting of oxygen to remove a portion of said etch residue, stopping said oxygen plasma contacting before said polymer etch residue is completely removed and thereafter removing any remaining said residue by contacting said opening with a second plasma, said second plasma consisting of hydrogen containing gas", similar limitations and that Zhao

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discloses the etching by oxygen plasma causing residue. The examiner disagreed, even though Zhao only expressly discloses one step of cleaning residue with hydrogen plasma, Zhao also discloses a step of removing photoresist by ashing (conventionally done with oxygen plasma), as shown in the rejection. The examiner argued that the oxygen plasma used to remove the photoresist also inherently remove the etch residue. It is well known in the art that the etching of openings in low k dielectric material containing at least organic portions results in polymeric residue, which is inherently removed by oxygen plasma (see Chen, par. bridging cols. 2-3). Because the oxygen plasma photoresist removing step is performed before the hydrogen plasma etch residue removing step, the contacting with oxygen has to stop before all the residue is removed and the remaining residue, including the metal oxide residue caused by the exposure of metal to oxygen plasma, is removed by the hydrogen plasma. If there is no resist left after the oxygen plasma then there is no need for a hydrogen plasma cleaning.

Applicants also argued that the combined teaching of Zhao and Chen does not teach the use of plasma consisting of hydrogen containing gas in the absence of added oxygen. The examiner disagreed, Chen discloses cleaning residue with plasma consisting of hydrogen in the absence of added oxygen (see col. 5), Chen's cleaning step is to reduce residue including metal oxide (Cu oxide), the objective would be defeated if oxygen causing oxidation of metal is added.

Note that applicant's arguments are largely directed to what the cited references teach individually. However, it is axiomatic that one cannot show nonobviousness by attacking references individually where the rejection, as here, is based on a combination of references. *In re Young*, 403 F.2d 754, 159 USPQ 725 (CCPA 1968); *In re Keller*, 642 F.2d 413, 208 USPQ 871 (CCPA 1981). For example, applicant argues that Smith does not disclose two plasma process for removal of etch residue as here claimed. However, Zhao, not Smith, is employed in the rejection to show that feature of the claimed process. Smith is used to show the equivalence of ammonia, hydrogen and methane plasma in the removal of organic materials included in the etch residue.

Therefore, the combined teaching of the applied references does teach or make obvious all the limitations of the rejected claims.

### ***Conclusion***

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8. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

9. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Ha T. Nguyen whose telephone number is (571) 272-1678. The examiner can normally be reached on Monday-Friday from 8:30AM to 6:00PM, except the first Friday of each bi-week. The telephone number for Wednesday is (703) 560-0528.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, John F. Niebling, can be reached on (571) 272-1679. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).



Ha Nguyen

Primary Examiner

11- 18 - 04